- Sunspot Classification Activity…To the Teacher
- National Standards application:
  - Content Standard D: Energy in the Earth System
  - —The Sun is the major external source of energy for the Earth. (Variations in sunspot activity has affected global climate here on Earth…London's Thames River froze over several seasons in the late 17th century.
  - --- Global climate (on Earth) is determined by energy transfer from the Sun.
- This activity works well when assigned to individual students or when working in small groups.
- It appears that the Stonyhurst grid on page 6 should have the center-cross (delineating 0 degees declination and 0 degrees latitude) displaced 10 degrees to the right—to coincide with the coordinates listed below the grid.
- Note: When viewing the Sun, longitude coordinates to the left of center are considered EAST and those to the right are considered WEST!
- Answer key is available via teacher's email request to mmathras@charter.net

Make no marks on these sheets!

Sunspot Classification

People like patterns. When we see a pattern, we can generally figure out what comes next. Scientists have been classifying sunspots for many years and in many ways. One method of classification, the Zurich Method of Sunspot Classification, was devised in 1938 by M. Waldmeier. In this activity, you will use a modified version of the Zurich Method to classify sunspots.

Vocabulary:

Umbra	The darkest, coolest portion of a sunspot
Penumbra	The lighter, warmer area surrounding the umbra of some sunspots
Pore	A dark spot on the Sun, essentially a sunspot umbra with no penumbra
*Unipolar group	A single spot or a single compact cluster of spots with the greatest distance between two spots of the cluster not exceeding three heliographic degrees.
*Bipolar group	Two spots or a cluster of many spots extending roughly east-west with the major axis exceeding a length of three heliographic degrees.

*Source: Solar Geophysical Data, 474 Supplement, Feb1984, pp. 21-23, US Dept of Commerce, Boulder CO 80303, USA

Procedure:

1. Trace the sunspots below. Outline the penumbra of each spot in green. Outline the umbra of each spot in red.
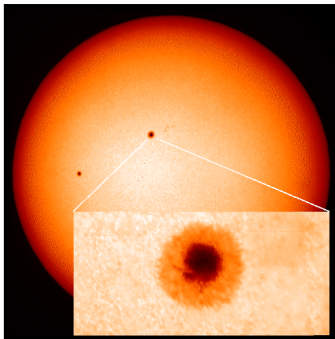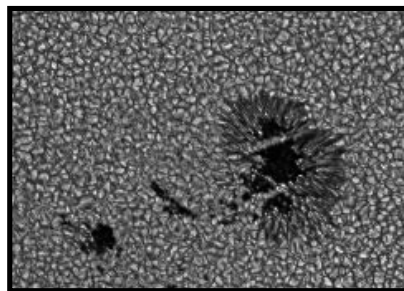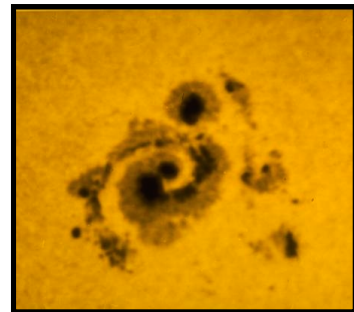

Image from University of Hawaii

Image from the Swedish Vacuum Telescope, La Palma Obsesrvatory

Image from Kitt Peak National Observatory

2. Look at these sunspots. Use the scale provided with each image to estimate the size of each sunspot group. Enter answers on a separate sheet.
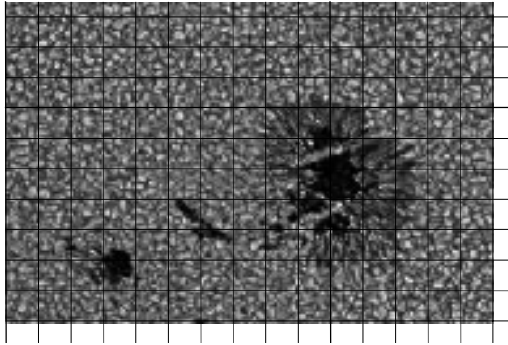

Image from La Palma Observatory
Scale: lines drawn at 3000 km intervals

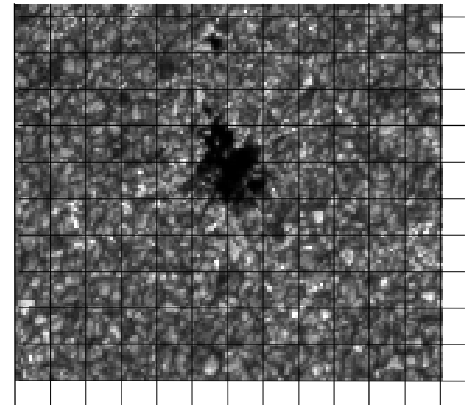A. Diameter of main spot: _____ km
    Length of group: _____ km

Image from La Palma Observatory
Scale: lines drawn at 1500 km intervals
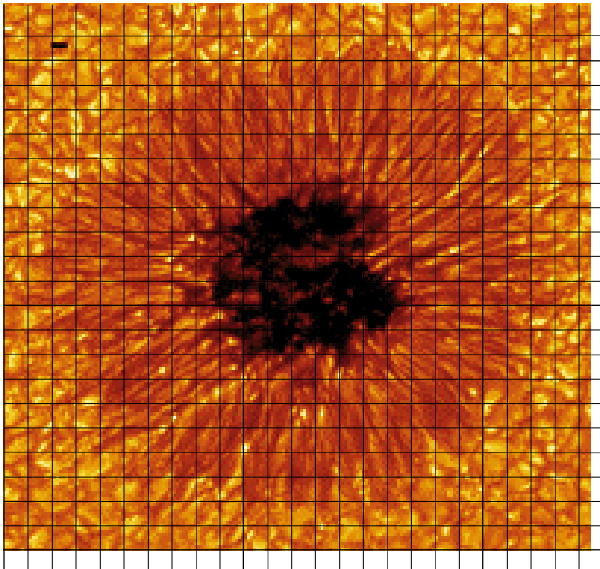
B. Diameter of pore: _____ km

Image from La Palma Observatory
Scale: lines drawn at 800 km intervals
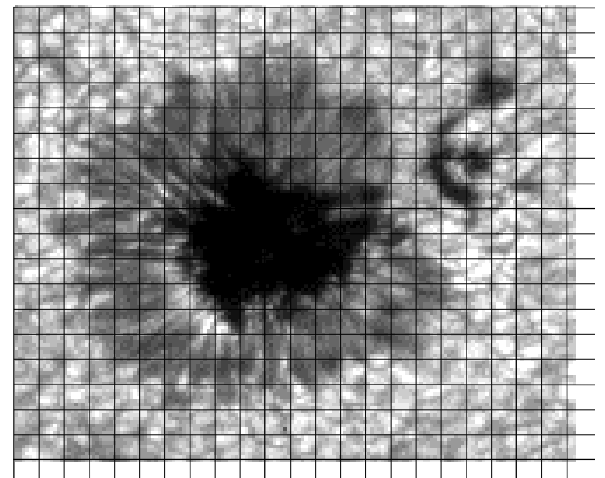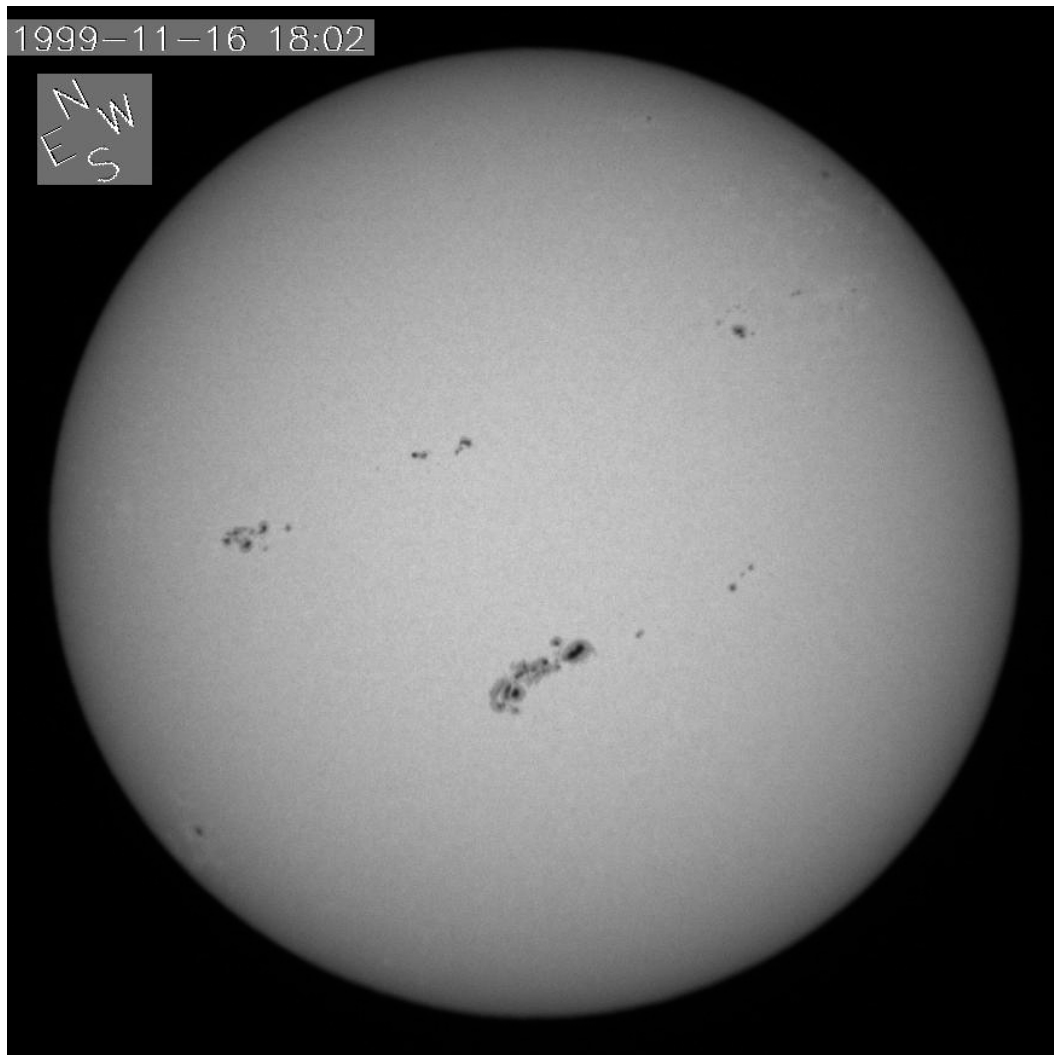
C. Diameter of sunspot: _____ km

Image from La Palma Observatory
Scale: lines drawn at 1000 km intervals

D. Diameter of sunspot: _____km
    Length of group: _____km

3. Look at this white light solar image from Big Bear Solar Observatory in California taken on November 16, 1999.

There are several neat sunspots and sunspot groups in this image. How do scientists classify all of these sunspots? Today, scientists use a combination of visual and magnetic characteristics. Take a look at the following table. It's a classification scheme you can use to classify sunspots and sunspot groups, based on their visual appearance.
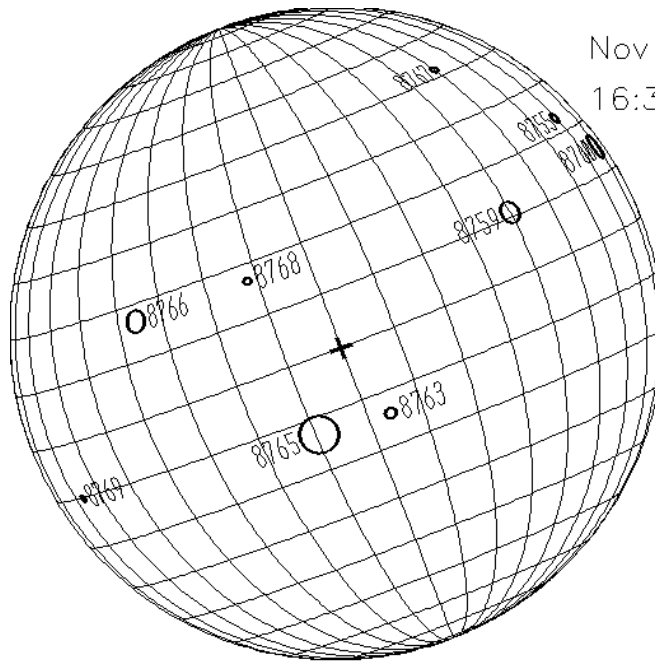
MODIFIED ZÜRICH CLASSIFICATIONS

Class A	A single spot or group of spots that: • Are unipolar. • Have no penumbra.
Class B	A group of spots that: • Are bipolar. • Have no penumbra.
Class C	A group of spots that: • Are bipolar. • Has spots with penumbrae - usually on only 1 side of an elongated group.
Class D	A group of spots that: • Are bipolar. • Has spots with penumbrae on both sides of an elongated group. • Has a group length of less than 10° of heliographic longitude.
Class E	A group of spots that: • Are bipolar. • Has spots with penumbrae on both sides of an elongated group. • Has a group length of between 10° and 15° of heliographic longitude.
Class F	A group of spots that: • Are bipolar. • Has spots with penumbrae on both sides of an elongated group. • Has a group length of greater than 15° heliographic longitude.
Class H	A single spot or group of spots that: • Are unipolar. • Have penumbrae.
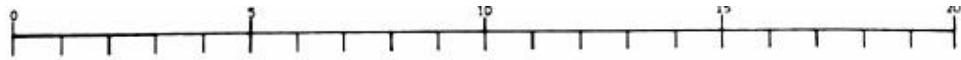
MODIFIED
ZURICH
CLASSES :
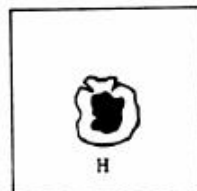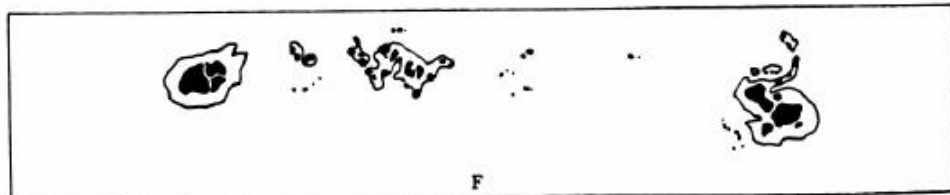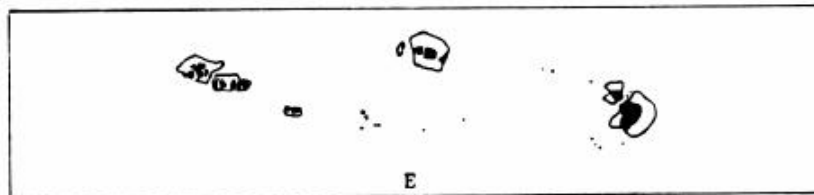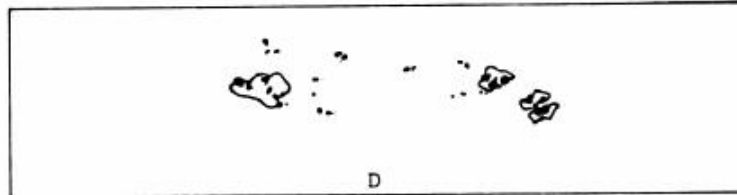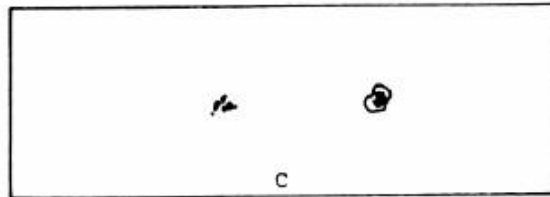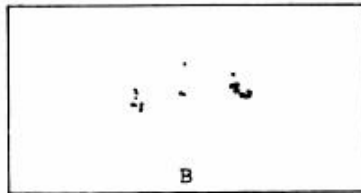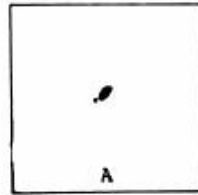
4. After you have looked at the previous tables of classifications, try to classify the sunspots and sunspot groups on the following solar image (either on the Internet or on a lab handout). This image is an active region map from Mees Solar Observatory in Hawaii. The data for this image was obtained on the same date as the white light image you viewed above. For this type of map, sunspot data is collected and then plotted on a Stonyhurst grid. Notice that each sunspot or sunspot group is given an official number (by the National Oceanic and Atmospheric Association, NOAA) and location. Also notice that there's more

Nov 16, 1999
16:32:09 UT

```
Joint USAF/NOAA Solar Region Summary (NOV 16,1999 00:00:00 UT)
------------------------------------------
NMBR LOCATI  LO  AREA  Z   LL  NN MAG TYPE
8755 N23W61 315 0080 HSX 02  01 ALPHA
8759 N11W32 286 0270 FAI 21  44 BETA-GAMMA
8760 N15W70 324 0420 FKO 17  11 BETA
8763 S14E04 250 0070 CSO 06  07 BETA
8765 S13E19 235 0820 EKC 14  34 BETA-GAMMA
8766 N17E44 210 0270 DKI 07  13 BETA-DELTA
8767 N42W42 296 0040 CSO 05  05 BETA
8768 N17E20 234 0030 DSO 06  07 BETA
8769 S10E76 178 0030 HSX 01  01 ALPHA
```

data on the page than you need (the LO, Area, Z, LL, NN, and Mag TYPE). The latitude and longitude lines on this map are spaced at 10° intervals. Use the information from the BBSO image, the modified Zurich Classifications, and the examples of modified classes, to classify each sunspot group. If you do not have internet access today, write your observations and classifications in the data table beneath the active region map on your handout. If you have internet access, complete the classification table beneath the active region map on the Internet page.

Number	Single or Group?	Bi-Polar or Unipolar?	Penumbra?	Length (^{o})	Classification
8765					
8766					
8759					
8768					
8769					